Magnetic random access memory (MRAM) element based on the triplet spin-valve effect for superconducting spintronics

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The theory of superconductor-ferromagnet (S-F) layered heterostructures with two and more ferromagnetic layers predicts generation of long-range, odd-in-frequency triplet pairing at non-collinear alignment of magnetizations of the F-layers [1]. Based on ideas of the superconducting triplet spin-valve [2,3] we observed switching of the $Co/CoO_x/Cu_{41}Ni_{59}/Nb/Cu_{41}Ni_{59}$ proximity coupled heterostructures between normal and superconducting states– triplet spin-valve effect has been detected [4].

In the present work a superconducting Co/CoO*x*/Cu41Ni59/Nb/Cu41Ni59 nanoscale thin film heterostructure is investigated, that exhibits a superconducting transition temperature, T_c, depending on the history of external magnetic field applied parallel to the film plane. In more detail, around zero value applied field T_c is lower if the field is swept from the negative to positive polarity (with respect to the cooling field), compared to the opposite case. We interpret this finding as a result of the triplet superconducting spin-valve effect arising at non-collinear alignment of magnetizations of two $Cu_{41}Ni_{59}$ layers. This interpretation is supported by superconducting quantum interference device magnetometry, which revealed a correlation between details of the magnetic structure and the spin-valve effect. Read-out of information is possible at zero applied field and, thus, no permanent field is required to stabilize the both states. Consequently, this system represents a superconducting magnetic random access memory (MRAM) element suitable for superconducting electronics. By applying increased transport currents, the system can be driven to the full switching mode between the completely superconducting and the normal conducting state.

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